

# Science at Work



Dr. Bridget Stutchbury is a biology professor at York University. Her research focuses on finding causes for why bird populations in the western hemisphere are declining.

## Canadians in Science

Dr. Bridget Stutchbury loved exploring nature and the outdoors as a child. She decided to turn her love of nature into a rewarding career. Today, she is a professor of biology at York University in Toronto and an expert on migratory birds. Dr. Stutchbury is trying to find out why bird populations in the western hemisphere are declining. She has written a book titled *Silence of the Songbirds*. In her book, she suggests that toxic pesticides and the loss of forests are the main causes of the dwindling number of songbirds.

### In Dr. Bridget Stutchbury's Words

The threats to migratory birds point to greater challenges for human society and for the environment. From the point of view of ecology, how we live today is not sustainable. Natural resources are not limitless. We need to develop better ways to manage the resources that we depend on.

This is an exciting time for students who are interested in ecology. Society is at the forefront of an environmental revolution. Many people in Canada, including leaders in governments and businesses, agree that we must change how we interact with our natural environment. This opens the doors to many career opportunities connected to ecology. There is a demand not only for solid technical skills, but also for good communication skills. People in science and related fields need to be able to write and speak effectively. We need good communication skills to share information about issues that affect ecosystems and to persuade governments and businesses to make the best decisions.

Studying science is valuable, even if you do not pursue a science career. Knowing about scientific methods will help you understand and evaluate results of research in subjects such as biology, chemistry, and medicine. This will help you to make informed decisions about personal issues, such as health and diet. And it will help you, as a consumer, make choices that will shape the ecology of tomorrow's world.



Researchers often capture and band birds to track their movements.

## Ecology at Work

The study of ecology contributes to these careers, as well as many more!



### Park Naturalist

Park naturalists develop education programs for park visitors of all ages. They often guide visitors on nature hikes. They also monitor the conditions of ecosystems within a park. Park naturalists usually have a university degree in forestry or environmental science.

### Zookeeper

Zookeepers take care of animals at zoos and aquariums. Their duties, however, include more than just feeding and checking the health of the animals. Zookeepers also help to collect data for research and scientific studies. In addition, they often help to manage breeding programs for rare and endangered species. Zookeepers study biology and zoology at university.

### Environmental Lawyer

Environmental lawyers help clients understand and obey laws and regulations that protect the environment. As well, environmental lawyers give advice to companies and other organizations about activities to conserve ecosystems and use natural resources efficiently. In Canada, governments often ask environmental lawyers to make recommendations about policy decisions related to important environmental issues.

Go to [scienceontario](#) to find out more



## Over To You

1. Dr. Stutchbury states that “threats to migratory birds point to greater challenges for human society and for the environment.” What do you think she means by this statement? Explain what you think are the main ecological challenges facing Canadians today.
2. Identify three strategies that Canadians could use to manage natural resources better. Share your strategies with a partner. What are the similarities and differences between your strategies and your partner’s strategies?
3. Growing scientific evidence suggests that loss of habitat and other major environmental threats are causing many bird populations to decline. How might a decline in a bird population affect an ecosystem?
4. From the list of careers related to ecology, choose one that interests you. Use Internet or print resources to research this career. What you would need to do if you wanted to pursue it? **What essential skills would you need for this career?**



# Unit 1 Projects

## Inquiry Project

### Pollutants and Aquatic Ecosystems

Many substances can dissolve in water. This does not mean that they disappear, however. It means that they are reduced to small particles. These particles can move with the water as it travels through the ground or from one ecosystem to another, such as from a stream to a river to a lake. As you have learned, some substances that are produced by humans pollute the aquatic ecosystems of the biosphere.

#### Inquiry Question

How do common substances affect the sustainability of aquatic ecosystems?

#### Initiate and Plan

1. Design at least two aquatic ecosystems, or *ecojars*. Use simple containers, such as large jars, modified 2 L soft-drink bottles, or small aquariums.
2. Plan what you will put in your ecojars by making a list of possible abiotic and biotic components.
3. Decide what substance(s) to investigate. Remember to use one of your ecojars as a control.
4. List the materials you will need, the steps in your procedure, and any safety precautions you should take.
5. Decide how you will measure the effects of each substance on the ecosystem.
6. Select an appropriate format, such as a table, to organize and record your data.
7. Formulate predictions about what will happen to the water and to the plants when you add each substance to the ecosystem.
8. Have your teacher approve the design of your investigation.

#### Perform and Record

9. Set up your ecojars, and conduct your investigation. Record your results.

#### Analyze and Interpret

1. Describe any patterns or trends you observed in the data you collected.
2. Did the trends in the data you collected match the predictions you made? Provide some possible explanations for any differences you observed.
3. Evaluate the design of your investigation. Were you able to control and identify the effects of variables? Was your measure of the effects of the substances accurate? What changes would you make to your design for future investigations on this topic?

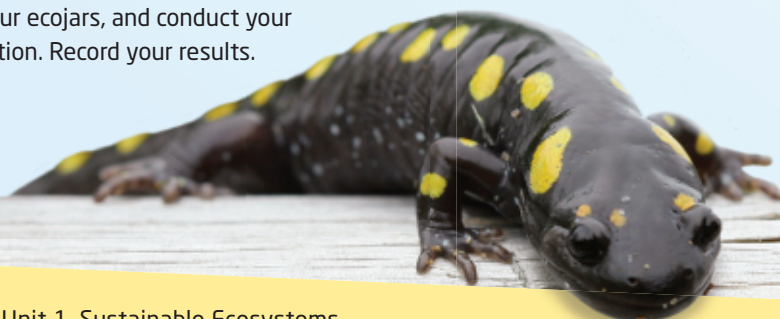
#### Communicate Your Findings

4. Present your results using both a visual component and a written component, taking into consideration both the purpose and the audience.

#### Assessment Criteria

Once you complete your project, ask yourself these questions. Did you...

- **K/U** provide an accurate description of the abiotic and biotic characteristics of the ecosystem?
- **T/I** formulate appropriate predictions for the impact of the investigated substance(s)?
- **T/I** control appropriate variables and use equipment and materials safely, accurately, and effectively?
- **T/I** analyze and interpret qualitative and quantitative data to determine whether the evidence supports or contradicts your initial predictions?
- **T/I** identify sources of error that may have influenced the outcome, and suggest improvements to the original design?
- **C** organize and record data appropriately?
- **C** take the purpose and audience into account?



## An Issue to Analyze

### Protecting Ecosystems

The Oak Ridges Moraine is a valuable ecosystem in Ontario. Diverse natural habitats, such as ancient forests and complex wetlands, provide living space for all kinds of organisms. Much of the water supply for the Greater Toronto Area begins in the ground-water system of the moraine's glacial soils.

To preserve this 1900 km<sup>2</sup> ecosystem from excessive development, a law was passed that placed strict controls on development. The Oak Ridges Moraine is only one of many special ecosystems in Ontario needing protection.

#### Issue

What can be done to protect a valuable ecosystem in your area?

### Initiate and Plan

1. Choose an ecosystem that needs protection (either a large ecosystem or a small green space near your home).
2. Research and describe the human factors that threaten or could threaten the ecosystem you have chosen. Think of some questions to help you focus your research. To do this, consider what issues are involved and what groups may have a stake in these issues. Consider researching some or all of the following questions:
  - Are there threats from erosion, deforestation, pollution, recreational overuse, wetland drainage, or housing developments?
  - Which threats to the ecosystem will you address?
  - Who will your audience be? Will you communicate directly with those who are posing the threats? Will you communicate with a government (municipal, provincial, or federal)? Will you seek the attention of the public through a newspaper, a media broadcaster, or a widely read blog?
3. Decide how you will conduct and record your research. What sources will you use?

### Perform and Record

4. Conduct your research to answer your questions.



### Analyze and Interpret

1. Based on your research, identify the threats to the ecosystem and explain the issues involved.
2. Explain the perspective of the people who are posing the threats. How do they justify their activities?
3. Propose one or more practical strategies that people, including you, could take to reduce or eliminate the threats.

### Communicate Your Findings

4. Choose an appropriate form of communication for your audience (for example, a newspaper article, a protest sign, or a podcast).

### Assessment Criteria

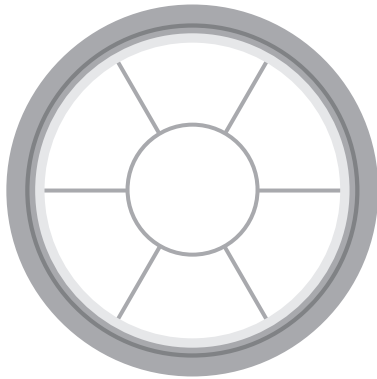
Once you complete your project, ask yourself these questions. Did you...

- **K/U** describe human factors that impact the ecosystem?
- **C** collect information from a variety of sources?
- **C** organize your information appropriately for your intended audience?
- **C** use appropriate scientific vocabulary?
- **A** analyze your information for bias and accuracy?
- **A** analyze your information to identify both the protection strategies and the obstacles?
- **A** propose alternative courses of action that could be taken to improve the status of the ecosystem?

# Unit 1 Review

## Connect to the **BIG IDEAS**

Use this bicycle wheel graphic organizer to connect what you have learned in this unit to the Big Ideas, found on page 1. Draw one bicycle wheel for each Big Idea and write the Big Idea in the centre. Between the spokes of the wheel, briefly describe six examples of that Big Idea.



## Knowledge and Understanding **K/U**

For questions 1 through 5, select the best answer.

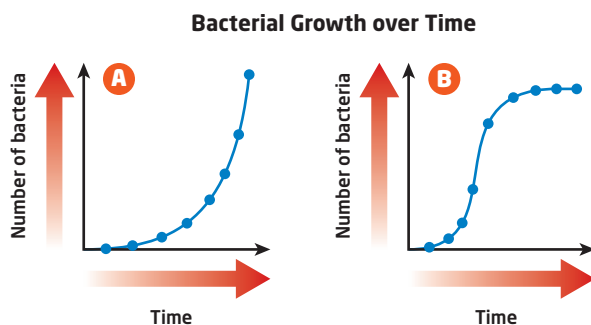
- The lithosphere is
  - the water in oceans on Earth
  - the non-living components of an ecosystem
  - the layer of air above Earth's surface
  - the hard part of Earth's surface
- Trophic efficiency is a measure of how much energy in organisms can be  from one trophic level to another.
  - lost
  - saved
  - spent
  - transferred
- The size of a population that can be supported indefinitely by the resources and services of an ecosystem is known as its
  - carrying capacity
  - ecological footprint
  - exponential limit
  - niche
- Which situation is an example of biomagnification?
  - A bear eats a large meal and stores the nutrients as fat.
  - A frog is poisoned by the nearby use of pesticides and dies soon after.
  - A hawk eats a fish that has eaten many smaller aquatic animals, which all had toxins in their bodies.
  - A caterpillar feeds on leaves that contain toxins, and the toxins are stored faster than they are eliminated.
- A low dose of insecticide is sprayed up, into the top of a tree. The insects that fall out as a result are collected, counted, and analyzed. This method of measuring biodiversity is called
  - canopy fogging
  - netting
  - quadrat sampling
  - transect sampling
- Nutrients were added at the Experimental Lakes Area to study eutrophication. Which nutrient had the greatest direct influence on eutrophication?
- Why has the level of carbon dioxide in the atmosphere been steadily increasing since the mid-19th century?
- The bird on the giraffe's head in the photograph below is called an oxpecker. The bird searches the hides of large mammals for parasites, which it harvests and eats. Identify whether the relationship between the bird and the mammal is an example of predation, competition, mutualism, or parasitism. Explain your answer.



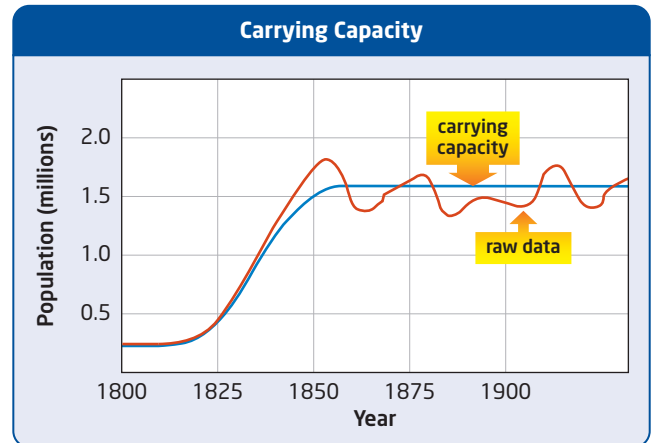
9. In your own words, describe the concept of urban sprawl.
10. What are two factors that have made it difficult for scientists to determine the number of species on Earth?
11. Identify two biodiversity hotspots in Canada.
12. Draw a diagram that shows the relationship between the water cycle and the phosphorous cycle.
13. How are plants used for bioremediation?
14. Explain how driving a car in Ontario could affect ecosystems elsewhere in Canada?
15. What happens to the energy in tertiary consumers when they die?

### Thinking and Investigation T/I

16. Use either the monarch butterfly or the ruby-throated hummingbird to explain how ecosystems are connected. Why is it important to maintain connectivity among ecosystems?
17. The graphs below represent the growth patterns of two different bacterial cultures over a period of time.
  - a. Analyze each graph. Describe, in words, what is happening in each bacterial culture.
  - b. Which graph shows only exponential growth?
  - c. Which graph shows a growth pattern that is exponential for part of the time?
  - d. Has either of these populations reached its carrying capacity? Explain your answer.



18. Estimate the carrying capacity for the population shown in the graph below. Why do you think the carrying capacity in real-life situations is not a smooth, flat line?



19. Different species provide many different services for their ecosystems by occupying their ecological niches. The red squirrel is a familiar Ontario species. Brainstorm a number of “services” that a red squirrel provides for the ecosystems in which it lives.
20. Explain how acid precipitation could affect biodiversity.
21. Study the following table. Identify two factors that may help to explain why Canadians have a larger ecological footprint than people in Vietnam.

#### Resource Use in Canada and Vietnam

Country	Canada	Vietnam
Size (km <sup>2</sup> )	9 985 000	330 000
Population (millions)	33	84
Population density (people/km <sup>2</sup> )	3.2	251.5
Annual electricity use (billion KW•h)	487	32
Oil consumption (barrels per day)	2 200 000	185 000
Highways (km)	1 408 800	93 300
Wealth generated per person per year (\$)	31 500	2 700

# Unit 1 Review

**22.** Imagine that you work as a lake ecologist at the Canadian Centre for Inland Waters. Create a questionnaire that a ship's captain, arriving at inland Canadian ports, would have to fill out.

## Communication **C**

**23.** Prepare a short paragraph that promotes the virtues of the greenhouse effect and its contribution to the development of life on Earth.

**24.** The maple leaf is a familiar symbol of Canada. Using an outline of a maple leaf, draw symbols at the five tips to represent the richness of Canada's ecosystems.



**25.** The ecosystem that includes prairie dogs and black-footed ferrets is complex. Create a flowchart that you could use as a visual aid if you were giving an oral presentation about this ecosystem to a Grade 5 class.

## Application **A**

**26.** Suppose that you are a science writer who is working on an article about the effects of the biomagnification of certain chemicals. What questions would you ask a group of scientists who recently created a new pesticide?

**27.** Many migratory birds travel great distances, living in ecosystems that are thousands of kilometres apart. The Canada warbler, a species in decline, breeds in Canada but spends the winter in several South American countries. Why is designing a plan to stabilize the Canada warbler population more challenging than designing a plan for a Canadian species that does not migrate?

**28.** Gulls and raccoons are organisms that have benefited from human development, particularly in urban areas. In Canada, black bears have benefited from the landfill sites created by humans.



Choose one of the following organisms, and propose a course of action to deal with their increased population growth. A few suggestions are given for each organism.

- Gulls: poison, disrupt nesting, post fines and prosecute for feeding, use birds of prey
- Raccoons: trap, sterilize, use raccoon-proof garbage containers
- Bears: educate the public, use better fencing, promote spring bear hunting, trap and relocate

**29.** Suppose that your community is looking for ideas to promote sustainable development. Describe an activity that is sustainable in your community. Contrast this activity with a non-sustainable activity to show how the sustainable activity uses resources more efficiently.

**30.** Many wetlands have been drained in southern Ontario, but some have been reclaimed through wetland restoration. Prepare a checklist that could be used to determine areas that are suitable for wetland restoration.

**31.** Both the eastern foxsnake and the queen snake have small Ontario ranges. Most of the world's eastern foxsnakes are found in Ontario, but the queen snake has a large range in the United States. How might this information influence your ideas for a conservation plan to protect snakes, if you have limited funds?

## Literacy Test Prep

Read the selection below, and answer the questions that follow it.

People in North America use resources at a greater rate per person, compared with people in many other countries in the world. If everyone on Earth consumed as much as the average person in North America does, three more Earths would be needed to sustain the human population. The following table contains data about resource use.

Resource Use in Canada and the World

Category	Canadian Average	Global Average
CO <sub>2</sub> produced from the consumption of fossil fuels and farm products, and the clearing of land per person, per year	17.0 tonnes	4.1 tonnes
Vehicles driven per 100 people, per year	47	9
Paper used per person, per year	281 kg	52 kg
Gasoline used per person, per year	1389 L	174 L
Fresh water used per person, per year	1494 m <sup>3</sup>	633 m <sup>3</sup>

## Multiple Choice

In your notebook, record the best or most correct answer.

32. The table above provides information about
- the amounts of resources used by the average person in North America, compared with the amounts used by the average person globally
  - the amounts of resources used by the average Canadian, compared with the amounts used by the average person globally
  - the amounts of resources used by people in different countries around the world
  - the amounts of resources used by the average person in the United States

33. How much paper is used by the average Canadian?
- 17.0 tonnes per year
  - 281 kg per year
  - 1389 L per year
  - 1494 m<sup>3</sup> per year
34. For which category is use by the average person in the world greater than use by the average Canadian?
- vehicles driven per 100 people, per year
  - gasoline used per person, per year
  - all of the categories
  - none of the categories
35. How does the data in the table support this statement: “If everyone on Earth consumed as much as the average person in North America does, three more Earths would be needed to sustain the human population?”
- For every category, the global average consumption is two to eight times higher than the Canadian average.
  - For every category, the Canadian average consumption is two to eight times higher than the global average.
  - The average Canadian uses only 174 L of gasoline per year.
  - The average person in the world uses 1494 m<sup>3</sup> of water per year.

## Written Answer

36. Make a list of how each resource use in the table affects the sustainability of ecosystems. Then write a paragraph about sustainable practices that might reduce the impact of Canadians on ecosystems.